Stabilization Policy with an Endogenous Commercial Bank

Mark Setterfield*

and

Kurt von Seekamm*

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Abstract

We extend the Carlin and Soskice (2005) 3-equation New Keynesian model by introducing a commercial bank that intermediates between the central bank and borrowers in the non-bank private sector. Commercial bank interest rate setting is explicitly modelled, and the implications for stabilization policy are studied. A surprising but important conclusion is that commercial bank behaviour has little impact on the success of stabilization policy, even when the central bank is ignorant of how the commercial bank behaves.

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*Department of Economics, Trinity College, Hartford, CT 06106, USA. An earlier version of this paper was presented at the IEPI conference "The Political Economy of Central banking," Toronto, Canada, May 2009. We re grateful to conference participants for their comments. Any remaining errors are our own.
Correspondence: mark.setterfield@trincoll.edu

1. Introduction

The three-equation New Keynesian or "new consensus" model is now a staple feature of monetary macroeconomics.[1] One common criticism of this model is that it retains pre-Keynesian notions of the workings of the real economy, as encapsulated in "natural" rates of interest and unemployment (Smithin, 2004; Setterfield, 2004, Lavoie, 2006). A second criticism is that in its eagerness to embrace the modern "science" of monetary policy, according to which the central bank manipulates the interest rate rather than the quantity of money in circulation, the new consensus has become divorced from the monetary theory of the private financial sector – in particular, the orthodox monetary-base-multiplier explanation of commercial banking, with which it is incompatible (Friedman, 2003).[2] The concern of this paper is with the second of these criticisms.

Various methods of integrating an account of private financial behaviour into the new consensus have already been proposed. Some seek to "recover" traditional *LM* analysis (see, for example, Tamborini 2009). Others, however, provide accounts of the financial sector that are consistent with the tenets of endogenous money theory, in which the behaviour of commercial banks and the loan-creation process are seen as the nexus of the monetary sector (see, for example, Howells 2009). Indeed, drawing on this second approach and motivated by the recent financial crisis, several authors have already begun to study the significance of exogenous shocks emanating from the private financial sector as a source of macroeconomic instability in new consensus models (Lavoie, 2009; Weise

[1] See, for example, Clarida et al (1999) and Woodford (2003) for canonical descriptions of this model.
[2] In the new consensus the quantity of money in circulation is a "residual", determined endogenously by the non-bank private sector's demand for loans and the willingness of commercial banks to issue loans to credit worthy households and firms at the ruling interest rate. This generates a demand for reserves on the part of commercial banks seeking to remain liquid as the loans they have created generate spending in the non-bank private sector, the receipts from which accrue as deposits in the banking sector. Hence the creation of broad money drives the creation of base money, rather than the other way around (as in the traditional monetary base multiplier story).

and Barbera, 2009). In this paper, we build on these latter contributions by *endogenizing* the behaviour of the private financial sector. Specifically, we amend a popular variant of the new consensus model by introducing a commercial bank which acts as an intermediary between the central bank and the non-bank private sector. Like the central bank, the commercial bank acts as a price maker, adding a premium or mark-up to the overnight rate set by the central bank to establish the commercial rate of interest at which households and firms borrow. This it does in accordance with an explicit reaction function. The key question that we address is: what if any effect does the behaviour of this financial intermediary have on macroeconomic stabilization policy?

The remainder of the paper is organized as follows. In section 2, we outline the baseline new consensus model on which our analysis builds. Section 3 then specifies the behaviour of the commercial bank that we introduce into this model. In section 4, we study the implications of the resulting amended model for macroeconomic stabilization policy. Section 5 draws some conclusions.

2. A baseline new consensus model

Our analysis is based on a variant of the new consensus model developed by Carlin and Soskice (2005). This variant suits our purposes well since it is designed to emphasize the behaviour of the central bank in its pursuit of macroeconomic stabilization.

In the Carlin-Soskice (hereafter C-S) model, the private sector is modelled in terms of two familiar equations: a standard IS curve; and an inertial Phillips curve embodying the accelerationist hypothesis.[3] These equations can be stated as follows:

$$y_1 = A - ar_0 \qquad [1]$$

$$\pi_1 = \pi_0 + \alpha(y_1 - y^e) \qquad [2]$$

where y and y^e are the actual and "natural" levels of output, respectively, r is the real interest rate and π denotes the rate of inflation. The private sector achieves equilibrium when $\Delta\pi = 0$ which, from [2], implies that $y = y_e$. Substituting this result into equation [1] and re-arranging, we obtain:

$$r_S = \frac{A - y^e}{a}$$

which Carlin and Soskice (2005, p.3) interpret as "the so-called 'stabilizing' or Wicksellian (Woodford) rate of interest such that output is in equilibrium when [$r = r_S$]".[4]

The central bank, meanwhile, is modelled as a forward looking social welfare maximizer with rational expectations. Without loss of generality (see Carlin and Soskice 2005, pp.3-13) the time horizon of the central bank is limited to one period ahead. Given this, and the fact that the underlying model of the private economy stated above is deterministic, the central bank can be described as possessing "myopic perfect foresight"

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[3] In terms of the variables that appear in equation [2], this hypothesis states that $y \neq y_e \Rightarrow \Delta\pi \neq 0$. Note that by retaining this hypothesis throughout the analysis that follows, we are setting aside the first of the two criticisms of the new consensus model identified earlier in favour of exclusive focus on the second. Drawing on the earlier work of Setterfield (2004) and Lavoie (2006), it would be straightforward to extend the analysis in this paper by either relaxing the accelerationist hypothesis or introducing hysteresis effects to replace the implicit assumption that the natural level of output is invariant with respect to the output gap. We leave such extensions to future research.

[4] A somewhat different interpretation of r_S is provided below.

(Flaschel et al, 1997). Formally, the central bank is described as engaging in the constrained optimization of a quadratic loss function. Its problem can be stated as:

$$\min_{r} L = (y_1 - y^e)^2 + \beta(\pi_1 - \pi^T)^2$$
$$s.t. \quad y_1 = A - ar_0$$
$$\pi_1 = \pi_0 + \alpha(y_1 - y^e)$$

or:

$$\min_{r} L = (A - ar_0 - y^e)^2 + \beta(\pi_0 + \alpha(A - ar_0 - y^e) - \pi^T)^2$$

The first order condition of this problem is:

$$\frac{dL}{dr_0} = -2a(A - ar_0 - y^e) - 2a\alpha\beta(\pi_0 + \alpha(A - ar_0 - y^e) - \pi^T) = 0$$

and solving this first order condition for r_0 yields:

$$r_0 = r_S + \frac{\alpha\beta}{a(1+\alpha^2\beta)}(\pi_0 - \pi^T) \qquad [3]$$

Equation [3] is the interest rate operating procedure (IROP) consistent with the objective of the central bank described above. Together with equations [1] and [2], it provides us with a full description of the workings of the economy in the C-S model.

It is straightforward to show by means of a conventional stability analysis that by following the IROP in [3], the central bank will succeed in leading the economy towards the equilibrium state described earlier (where output is at its natural rate and inflation achieves a steady state). Hence note that, assuming $\Delta\pi \approx \dot{\pi}$, equation [2] can be re-written as:

$$\dot{\pi} = \alpha(y - y^e) \qquad [4]$$

while differentiating equations [1] and [3] with respect to time yields:[5]

$$\dot{y} = -a\dot{r}$$

and:

$$\dot{r} = \frac{\alpha\beta}{a(1+\alpha^2\beta)}\dot{\pi}$$

Substituting the second of these expressions into the first and then substituting equation [4] into the result gives us:

$$\dot{y} = \frac{-\alpha^2\beta}{(1+\alpha^2\beta)}(y - y^e) \qquad [5]$$

Equations [4] and [5] provide two differential equations in two unknowns (y and π), which can be expressed in matrix form as:

$$\begin{bmatrix} \dot{y} \\ \dot{\pi} \end{bmatrix} = \begin{bmatrix} \frac{-\alpha^2\beta}{(1+\alpha^2\beta)} & 0 \\ \alpha & 0 \end{bmatrix} \begin{bmatrix} y \\ \pi \end{bmatrix} + \begin{bmatrix} \frac{\alpha^2\beta}{(1+\alpha^2\beta)} y^e \\ -\alpha y^e \end{bmatrix} \qquad [6]$$

Inspection of [6] reveals that $\text{Tr}\, J = \frac{-\alpha^2\beta}{(1+\alpha^2\beta)} < 0$ and $|J| = 0$. The system is therefore stable but involves a zero root, which has implications for its equilibrium solution. More specifically, as is obvious from inspection of equations [4] and [5], imposition of the equilibrium conditions $\dot{y} = \dot{\pi} = 0$ yields a unique equilibrium value of output (y^e), but the corresponding equilibrium rate of inflation is indeterminate. It can therefore be noted in passing that the interest rate r_S is not *the* stabilizing interest rate consistent with $y = y^e$ (as is claimed by Carlin and Soskice, 2005, p.3). Instead, as inspection of the IROP in [3] reveals (in light of the stability results derived above), there are *many* such stabilizing

[5] Note that, in converting to continuous time analysis, time subscripts are dropped from all variables both here and elsewhere in the paper.

interest rates, depending on the precise steady state rate of inflation (π^*) that the economy achieves, and hence the precise equilibrium value of the "inflation target gap" $\pi^* - \pi^T$ that will appear (in equilibrium) on the right hand side of equation [3]. What r_S in fact denotes is the unique "fully adjusted" value of the interest rate. In other words, it is the value that the interest rate attains when the economy reaches a "fully adjusted position": a position of equilibrium that is also consistent with the realization of the target values of all variables (in this case, the central bank's target rate of inflation). Once again this is made clear by inspection of equation [3], according to which the particular steady state rate of inflation $\pi^* = \pi^T$ will yield $r = r_S$.

3. An endogenous commercial bank

The preceding analysis demonstrates that in the C-S model, a central bank that pursues monetary policy by adjusting the interest rate in accordance with equation [3] will succeed in stabilizing the economy in response to shocks. But an obvious shortcoming of this model is that it provides no description of the private financial sector. It is as if the central bank lends directly to households and firms – something that is very obviously at variance with reality. This is undesirable, not least because greater realism was part of the motivation for developing the new consensus model in the first place (see, for example, Romer, 2000).

We remedy this shortcoming by introducing into the C-S model a commercial bank, which acts as an intermediary between the central bank on one hand and households and firms on the other. It does so by lending to credit worthy borrowers in the non-bank private sector at an interest rate of its own making, which is arrived at by marking up the overnight rate at which it can lend from the central bank.[6] Formally, we begin (following Lavoie (2009) and Weise and Barbera (2009)) by writing:

$$r_0 = \varphi_0 + \theta_0 \qquad [7]$$

where φ is the overnight interest rate set by the central bank, and θ is the mark up that the commercial bank adds to this overnight rate to establish the commercial interest rate (r) faced by borrowers in the non-bank private sector. The commercial bank mark up reflects both the term structure of the loans it makes (which we take as given) and other sources of lender's risk (see also Lavoie, 2009). However, unlike Lavoie (2009) and Barbera and Weise (2009), who take the value of θ as exogenously given, we identify macroeconomic influences on the commercial bank's perception of lender's risk and hence model θ as an endogenous reaction to the state of the economy. Formally, we describe the commercial bank as setting its mark up in accordance with a reaction function of the form:

$$\theta_0 = \theta(y_1^E, \pi_1^E, \varphi_0^E, \rho_0) \qquad [8]$$

where an E-superscript denotes the expected value of a variable and ρ is increasing in influences on the commercial bank's perception of lender's risk that are not captured by the other variables in [8] (including their animal spirits). Note that, like the central bank, the commercial bank is forward looking over a limited time horizon of one period, and has some information about the lag structure of the economy (understanding that once it has formed an expectation of φ_0, it can anticipate the value of y_1 and hence π_1).

[6] Throughout the analysis that follows we implicitly assume that the commercial bank's standard for credit worthiness is constant, and focus attention on its manipulation of the mark up and hence (given the central bank's overnight rate) the commercial interest rate. It is possible, of course, that commercial banks are as if not more inclined to alter their conventional standards for evaluating credit worthiness – and hence the proportion of loan applications they deem credit worthy – in response to the perceived sources of variation in lender's risk that we discuss below (see, for example, Rochon, 2006). We leave investigation of this possibility to future research, but see Fontana and Setterfield (2009) for a preliminary investigation based on exogenous variation in commercial banks' standards of credit worthiness.

Furthermore, we assume that $\theta_y < 0, \theta_\pi > 0, \theta_\varphi < 0$, and $\theta_\rho > 0$. The sign of the last derivative is obvious from the definition of ρ, but the other derivatives merit some explanation. First, we hypothesize that if commercial banks expect y to fall or π to rise, they will interpret either event as signalling a deterioration in the general state of the economy which raises the prospect of default by borrowers and thus increases lender's risk.[7] Hence the mark up will rise in response to either a fall in expected output or a rise in expected inflation ($\theta_y < 0, \theta_\pi > 0$). Of course, to the extent that it issues loans at fixed interest rates, a rise in the rate of inflation will also diminish the real value of the commercial bank's existing loan portfolio, which may also provoke it to raise rates on new loans issued in response to higher expected inflation.[8] Second, we hypothesize that the commercial bank believes that an information asymmetry exists as between itself and the central bank – specifically, that the central bank has more and/or better information about the likely future state of the economy. Hence the commercial bank will raise its mark up if the central bank cuts its overnight rate ($\theta_\varphi < 0$), because independently of its output expectations, the commercial bank will perceive a cut in φ to be an indication of weakness in the general state of the economy, and hence an increase in the risk of default and the associated lender's risk. This behaviour is in keeping with empirical evidence which suggests that, in the US, the Federal Funds rate is negatively correlated with credit spreads (Weise and Barbera, 2009).

[7] A reduction in output and hence income will diminish the ability of debtors to service their loans, thus increasing the risk of default. Meanwhile, an increase in inflation may be interpreted by the commercial bank as an indicator of future interest rate hikes by the central bank (which will reduce income and thus increase the risk of default).

[8] In addition, and despite the fact that [8] describes the determination of a *real* interest rate mark up, the sign of θ_π can be interpreted as a psychological response resulting from lenders' deep aversion to inflation.

Our approach to modelling commercial bank behaviour is similar to that of Palley (2008). Like Palley, we posit that θ is sensitive to real output and to the animal spirits of the commercial bank. Unlike Palley, however, we overlook the influence of asset prices and the volume of loans on θ, while taking into account the effects of inflation and the commercial bank's reaction to *central* bank behaviour. Of the two omissions mentioned above, the first is explained by the fact that our model does not include an asset market, and the second by the fact that we abstract from structuralist concerns with the response of commercial interest rates to the expansion of commercial banks' loan portfolios (on which see, for example, Pollin, 1991). Further discussion of the first omission appears in the conclusion of our paper.[9]

In order to incorporate commercial bank behaviour into our model, we make the simplifying assumption that the mark up rule in [8] is linear, which allows us to write:

$$\theta_0 = \varepsilon y_1^E + \gamma\pi_1^E + \eta\varphi_0^E + \mu\rho_0 \qquad [9]$$

where, in accordance with [8], $\varepsilon, \eta < 0$ and $\gamma, \mu > 0$. Finally, we assume that $x^E = x \ \forall \ x = y, \pi, \varphi$ in [9], so that the final version of our commercial bank reaction function can be written as:

$$\theta_0 = \varepsilon y_1 + \gamma\pi_1 + \eta\varphi_0 + \mu\rho_0 \qquad [10]$$

It could be argued that this last assumption is tantamount to assuming that (like the central bank) the commercial bank has myopic perfect foresight. This assumption sits uneasily with our model of commercial bank behaviour and, in particular, our claim that the commercial bank reacts to changes in φ on the basis of a perceived information

[9] The second omission is of less significance for our purposes, since as shown by Palley (2008), its incorporation would result only in the possibility that $\theta_y > 0$. This would only serve to reinforce the results derived in section 4 regarding the prospects for successful stabilization policy.

asymmetry between itself and the central bank – a perception that would be difficult to justify in the long run if the commercial bank repeatedly proved to be every bit as adept at forecasting output and inflation as the central bank. But an alternative interpretation is that we are simply abstracting from expectational error on the part of the private sector in the analysis that follows, in order to focus attention on other features of the model's adjustment dynamics – much as did Keynes (1936) in his exposition of the principle of effective demand in the *General Theory*. Relaxing our assumption about commercial bank expectations would potentially enrich the dynamics of our model, but would require that we specify exactly how these expectations are formed and (in the event that they are incorrect) updated. We leave this task to future research.[10]

We are now in a position to evaluate the consequences of commercial bank behaviour for the central bank's macroeconomic stabilization policies. It is to this task that we now turn.

4. Macroeconomic stabilization with an endogenous commercial bank

Our first objective is to derive anew the central bank's IROP, bearing in mind that the monetary policy operations of the central bank are now complicated by the behaviour of the commercial bank as captured in [10]. The easiest way of performing this task is to re-state the central bank's decision making problem from section 2 in the manner in which it was originally formulated by Carlin and Soskice (2005, p.13):[11]

[10] See, for example, Lima and Setterfield (2008) for an preliminary analysis, in the context of a macrodynamic model, of expectations formation by decision makers whose information about the future is deficient.

[11] Note that the original IROP in equation [3] can also be derived in this fashion. See Carlin and Soskice (2005, p.13).

$$\min_y L = (y_1 - y^e)^2 + \beta(\pi_1 - \pi^T)^2$$
$$\text{s.t} \quad \pi_1 = \pi_0 + \alpha(y_1 - y^e)$$

which, upon substitution, can be re-stated as:

$$\min_y L = (y_1 - y^e)^2 + \beta(\pi_0 + \alpha(y_1 - y^e) - \pi^T)^2$$

The first order condition of this decision problem is:

$$\frac{\partial L}{\partial y} = 2(y_1 - y^e) + 2\alpha\beta(\pi_0 + \alpha(y_1 - y^e) - \pi^T) = 0$$

and solving this first order condition for the output gap yields:

$$(y_1 - y^e) = \frac{-\alpha\beta}{1 + \alpha^2\beta}(\pi_0 - \pi^T) \qquad [11]$$

Equation [11] captures what Carlin and Soskice (2005, p.13) term the "monetary rule". It describes the trade-off between future output and current inflation that is acceptable to the central bank (i.e., consistent with the minimization of its loss function) given the constraints imposed by the structure of the private economy.

Now note that it follows from the IS curve in equation [1] that:

$$y^e = A - ar_S$$

where r_S is the "fully adjusted" value of the interest rate, as described earlier. Subtracting this expression from equation [1] yields a second expression for the output gap of the form:

$$y_1 - y^e = -a(r_0 - r_S) \qquad [12]$$

If, drawing on equation [7], we now write:

$$r_S = \varphi_S + \theta_S$$

where $\theta_S = \varepsilon y^e + \gamma\pi^T + \eta\varphi_S + \mu\bar{\rho}$ and $\bar{\rho}$ represents the "normal" value of ρ, then by substituting this expression and equation [7] into equation [12], we arrive at:

$$y_1 - y^e = -a[(\varphi_0 - \varphi_S) + (\theta_0 - \theta_S)] \qquad [13]$$

Substituting into [13] for θ_0 and θ_S yields:

$$y_1 - y^e = -a[(\varphi_0 - \varphi_S) + \varepsilon(y_1 - y^e) + \gamma(\pi_1 - \pi^T) + \eta(\varphi_0 - \varphi_S) + \mu(\rho_0 - \bar{\rho})]$$

and if we then substitute the Phillips curve in equation [2] into this last expression and solve for the output gap, we arrive at:

$$y_1 - y^e = \frac{-a}{1 + a(\varepsilon + \alpha\gamma)}\left[(1+\eta)(\varphi_0 - \varphi_S) + \gamma(\pi_0 - \pi^T) + \mu(\rho_0 - \bar{\rho})\right]$$

Finally, substituting this last expression into the monetary rule derived earlier yields:

$$\frac{-\alpha\beta}{1 + \alpha^2\beta}(\pi_0 - \pi^T) = \frac{-a}{1 + a(\varepsilon + \alpha\gamma)}\left[(1+\eta)(\varphi_0 - \varphi_S) + \gamma(\pi_0 - \pi^T) + \mu(\rho_0 - \bar{\rho})\right]$$

and solving for φ_0, we get:

$$\varphi_0 = \varphi_S + \frac{1}{1+\eta}\left[\frac{\alpha\beta(1 + a\varepsilon) - a\gamma}{a(1 + \alpha^2\beta)}(\pi_0 - \pi^T) + \mu(\rho_0 - \bar{\rho})\right] \qquad [14]$$

The expression in [14] is now the central bank's IROP.

Comparing equations [3] and [14], two observations regarding the implications of commercial bank behaviour for central bank stabilization policy are immediately apparent. First, it is evident that, with an endogenous commercial bank, the central bank requires more information (specifically, knowledge of the parameters η, ε, γ, μ, and $\bar{\rho}$ together with the variable ρ_0) in order to conduct monetary policy in accordance with its objective function. Whether or not the central bank has access to this information is, of course, open to debate. Second, even if we assume that the central bank *does* possess the information demanded by equation [14], commercial bank activity will affect the *extent* to which the central bank needs to vary the overnight interest rate in order to stabilize the economy. In the first place, since $\varepsilon < 0$, we will observe $\alpha\beta(1+a\varepsilon) - a\gamma < \alpha\beta$. Other things equal, this means that, in response to any given change in the rate of inflation, the variation in the overnight rate required by equation [14] is smaller than that required by [3]. However, the fact that $\eta < 0$ means that, other things equal, the response of the overnight rate to any given change in the rate of inflation required by [14] is *larger* than that required by [3]. Moreover, in equation [14], the central bank will need to vary the overnight rate in response to changes in ρ, a factor that is absent altogether from [3]. These last two consequences of commercial bank activity, which demand (other things being equal) *greater* variation in the overnight rate, may pose problems for the central bank in light of the zero lower bound constraint on the value of the nominal interest rate.

But these issues apart, what, if any, consequences does endogenous commercial bank activity have for the ability of the central bank to stabilize the economy? In order to answer this question, first note that if we combine equations [2], [7] and [10] and then substitute the result into equation [1], we arrive at the modified IS curve:

$$y_1 = \frac{1}{1+a(\varepsilon+\alpha\gamma)}\left[A - a([1+\eta]\varphi_0 + \gamma[\pi_0 - \alpha y^e] + \mu\rho_0)\right]$$

Assuming that $\rho_0 = \bar{\rho}$ and differentiating the modified IS curve with respect to time yields:

$$\dot{y} = \frac{-a}{1+a(\varepsilon+\alpha\gamma)}\left[(1+\eta)\dot{\varphi} + \gamma\dot{\pi}\right] \quad [15]$$

Meanwhile, it follows from the IROP in [14] that:

$$\dot{\varphi} = \frac{\alpha\beta(1+a\varepsilon) - a\gamma}{(1+\eta)a(1+\alpha^2\beta)}\dot{\pi} \quad [16]$$

Finally, substituting [16] into [15] and then substituting equation [4] into the result yields:

$$\dot{y} = \frac{-\alpha^2\beta}{(1+\alpha^2\beta)}(y - y^e)$$

It is immediately obvious that this last expression is exactly the same as the equation of motion in equation [5]. In other words, despite the introduction of an endogenous commercial bank, the dynamics of the economy are still described by [6], and the system has exactly the same stability properties as the baseline model discussed in section 2.

At first, this result may seem counter-intuitive. But on second thoughts there is a straightforward explanation. Even though our model has been complicated by the introduction of an endogenous commercial bank, the central bank has rational expectations (specifically, myopic perfect foresight). As such, the central bank simply takes into account the complications introduced by commercial bank behaviour, acts accordingly (with respect to its interest rate setting behaviour), and the result is successful stabilization policy (in the event of a shock, the economy will be propelled back to its natural level of output and to a steady-state rate of inflation).

But what if the information demands placed on the central bank by equation [14] are excessive? In other words, what effect will commercial bank activity have on stabilization policy if the central bank suffers an incomplete understanding of commercial bank behaviour? In order to address this question, consider the extreme case where the "true model" of the private sector is given by equations [1], [2], [7] and [10], but where the central bank's model of the economy comprises equations [1], [2], [7] and:

$$\theta = \overline{\theta} \qquad [10a]$$

In other words, the central bank is aware that the commercial bank acts as a financial intermediary and that it does so by marking up the overnight rate. But it is completely ignorant of the basis on which this mark up is established and instead treats θ as a constant. In this scenario, the "true" dynamics of the private economy are once again summarized by equations [4] and [15]. But by combining equations [1], [7] and [10], the central bank now believes that the IS curve of the economy can be written as:

$$y_1 = A - a(\varphi_0 - \overline{\theta})$$

so that:

$$y^e = A - a(\varphi_S - \overline{\theta})$$

Subtracting the second of these expressions from the first yields:

$$y_1 - y^e = -a(\varphi_0 - \varphi_S)$$

Finally, substituting this last expression into the central bank's monetary rule in equation [1] and solving for φ_0 yields:

$$\varphi_0 = \varphi_S + \frac{\alpha\beta}{a(1+\alpha^2\beta)}(\pi_0 - \pi^T) \qquad [17]$$

Equation [17] describes the central bank's IROP under conditions of complete central bank ignorance of commercial bank behaviour. Perhaps not surprisingly, the IROP is essentially the same as that in equation [3] (i.e., in the original C-S model, in which there is no commercial bank).

It follows from equation [17] that:

$$\dot{\varphi} = \frac{\alpha\beta}{a(1+\alpha^2\beta)}\dot{\pi}$$

Substituting this expression into equation [15], and then substituting equation [4] into the result yields:

$$\dot{y} = \frac{-\alpha[(1+\eta)\alpha\beta + a\gamma(1+\alpha^2\beta)]}{[1+a(\varepsilon+\alpha\gamma)](1+\alpha^2\beta)}(y - y^e) \qquad [18]$$

The dynamics of the economy are now represented by equations [4] and [18], a system that can be summarized as:

$$\begin{bmatrix} \dot{y} \\ \dot{\pi} \end{bmatrix} = \begin{bmatrix} \Omega & 0 \\ \alpha & 0 \end{bmatrix} \begin{bmatrix} y \\ \pi \end{bmatrix} + \begin{bmatrix} \Omega y^e \\ -\alpha y^e \end{bmatrix} \qquad [19]$$

where:

$$\Omega = \frac{-\alpha[(1+\eta)\alpha\beta + a\gamma(1+\alpha^2\beta)]}{[1+a(\varepsilon+\alpha\gamma)](1+\alpha^2\beta)}$$

It is clear from the expression in [19] that $|J| = 0$ and $\mathrm{Tr}\, J = \Omega < 0$ if:

$$(1+\eta)\alpha\beta + a\gamma(1+\alpha^2\beta) > 0 \;\Rightarrow\; \eta > -\left[1 + \frac{a\gamma(1+\alpha^2\beta)}{\alpha\beta}\right]$$

and:

$$1 + a(\varepsilon + \alpha\gamma) > 0 \;\Rightarrow\; \varepsilon > -\left[\frac{1}{a} + \alpha\gamma\right]$$

Although there are now stability conditions that must be met in order for the central bank's stabilization policy to be successful, both of these conditions are plausible. Hence the first condition requires only that the commercial bank's reaction to changes in the overnight rate not be "too large" (specifically, somewhat more than proportional). While this condition might be violated during a time of economic and financial crisis (as experienced from late 2007 through early 2009, for example), it otherwise appears reasonable. The second condition again requires only that the commercial bank's reaction to changes in output not be "too large". Given that the parameter *a* – the interest-sensitivity of output – is often regarded as small by critics of the efficacy of monetary policy (see, for example, Arestis and Sawyer, 2004), it is likely that "too large" means, once again, somewhat more than proportional. And while, once again, this condition may be violated during a time of economic and financial crisis, it otherwise appears plausible.

The upshot of these results is that the stability of the economy is robust to the introduction of endogenous commercial bank behaviour and (under certain – plausible – conditions) central bank ignorance of this behaviour. In other words, apart from under special case conditions that would appear to most closely resemble "depression economics", central bank stabilization policy will succeed in restoring the economy to the natural level of output and to a steady-state rate of inflation following a macroeconomic shock, even if the monetary transmission mechanism is complicated by a commercial bank that responds endogenously to changes in the state of the economy and to central bank policy, and even if the central bank is ignorant of the precise behaviour of the commercial bank in this regard.

5. Conclusion

On the face of it, the introduction of an endogenous commercial bank acting as an intermediary between the central bank and households and firms would appear to make effective stabilization policy more difficult to pursue. To some extent, this intuition is borne out by the results in this paper. First, the amount of information that the central bank requires in order to conduct monetary policy in accordance with its objective function is increased – at least in principle. Second, the extent to which the central bank must vary the overnight interest rate in order to stabilize the economy may be increased, with the result that the zero lower bound constraint on the value of the nominal interest rate is more likely to confound monetary policy.

And yet the analysis suggests that otherwise, the introduction of an endogenous commercial bank has little effect on the capacity of the central bank to stabilize the economy – even when it is fundamentally ignorant of commercial bank behaviour, so that it falls foul of the first problem identified above. This last result does require that certain stability conditions hold. These conditions may not be satisfied in the event of acute financial distress, lending some credence to Goodhart's (2008) argument that the new consensus is a "fair weather" model. But in general the stability conditions required appear plausible, and we are left with the result that the standard new consensus model can be "stressed" to the extent contemplated in this paper without it substantially affecting the prospects for successful stabilization policy.

Two possible conclusions follow. The first is essentially pessimistic: the result reported above does not establish that stabilization policy can survive any and all "stresses" emanating from private financial behaviour, and the model developed in this paper may simply lack the sophistication necessary to demonstrate this. We have already noted that the model abstracts from the dynamics of asset markets and their potential impact on borrowing and lending behaviour (and aggregate demand formation) – although Palley (2008), whose model does include an asset market, does not stress asset prices as a significant destabilizing force. Another and potentially more important omission is the endogenous accumulation of stock-flow imbalances (such as increases in the debt-income ratio of households), which recent experience suggests may have large and discontinuous effects on commercial bank assessments of lender's risk.

The second conclusion is optimistic: subject to the limitations noted above, the analysis demonstrates that policy makers need be far from omniscient in order to successfully stabilize the economy most of the time. In fact, the analysis towards the end of section 4 incorporates a classic "Lucas (1976) critique" problem, in which the central bank's structural model of private sector behaviour treats as parametric a variable (θ) that is endogenous to the central bank's own policy interventions. And yet, under plausible conditions, this has no effect on the efficacy of stabilization policy. The upshot of this result is that policy intervention can be beneficial even when its design and conduct is demonstrably imperfect.

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